Impact of Stream Management Zones and Road Beautifying Buffers on Long-Term Fiber Supply in Georgia

Michal Zasada[1], **Chris J. Cieszewski**[2], **and Roger C. Lowe**[3]

Abstract.—Streamside management zones (SMZs) and road beautifying buffers (RBBs) in Georgia have had an unknown impact on the available wood supply in the state. We used Forest Inventory and Analysis data, Landsat Thematic Mapper imagery, Gap Analysis Program and other geographic information system data to estimate the potential impact of SMZs and RBBs in the current and future Georgia forest inventories. The analyzed scenarios are based on long-term simulations of wood supply in the State under various assumptions of regulatory constraints, expected harvesting, and intensities of management practices. The results are expressed in the form of affected areas and volumes. Obtained results suggest that introducing only some of the harvesting constraints would not drastically affect sustainable fiber supply in the State, even in the presence of increased future harvesting. The cumulative impact of obligatory SMZs, RBBs, and other anticipated factors, such as potential loss of forested land to urban expansion, could have a strong negative impact on the level of sustainable harvesting, reducing the future fiber supply in Georgia.

A streamside management zone (SMZ) is a mandated protection zone around a stream, lake, or other water body, usually containing the bank vegetation and strip of forest. This zone must be protected because of its special importance for water quality. Riparian zones help maintain water quality, buffer rivers from adjacent pollution sources, filter sediments, absorb nutrients, stabilize stream banks, provide habitat and food for some animals and plants, and moderate stream temperature (Welsch 1991).

In 1976, the U.S. Environmental Protection Agency recommended using Best Management Practices (BMPs) as a primary method for controlling nonpoint source pollution (NPSP). The State of Georgia chose a nonregulatory system of voluntary compliance, which now is based on "Georgia's Best Management Practices for Forestry" issued by the Georgia Forestry Commission in 1999.

Although a large number of studies on riparian/streamside management zones have been conducted in the South (Wenger 1999, for example), the literature on their extent assessment and other statistics is scarce. For perennial streams, BMPs currently recommend leaving evenly distributed 50 square feet of basal area per acre or at least 50 percent of the canopy cover after a harvest. If the stream is classified as a trout stream, BMPs recommend creating an additional no-harvest zone around the stream's bank. For intermittent streams, requirements include leaving 25 square feet of basal area per acre or at least 25 percent of canopy cover after a harvest (GFC 1999). The impact of these potential harvesting limitations on long-term wood supply in the State remained unknown. In the future, Georgia may face the possibility of introducing mandatory BMPs for all forested areas. The current standards for BMPs may also change to more closely meet demands of environmental organizations calling for widening of the required buffers around streams and further restricting the forest management inside of them (Wenger 1999), having an unknown impact on the State's wood production capability.

Objectives

The primary objective of this study was to evaluate, based on available data, the impact of harvest constraints in the protective zones on long-term wood supply in Georgia. We used large-

[1] Postdoctoral Fellow, D.B. Warnell School of Forest Resources, University of Georgia, Athens, GA; Assistant Professor at Division of Dendrometry and Forest Productivity, Faculty of Forestry, Warsaw Agricultural University, 02-776 Warsaw, Poland, and Corresponding Author. E-mail: mzasada@dendro.sggw.waw.pl.

[2] Associate Professor, D.B. Warnell School of Forest Resources, University of Georgia, Athens, GA.

[3] GIS Analyst, D.B. Warnell School of Forest Resources, University of Georgia, Athens, GA.

scale estate simulation software and a spatially explicit Georgia forest inventory database developed from the Forest Inventory and Analysis (FIA) inventory data, Landsat Thematic Mapper (LTM) images, and various geographic information system (GIS) data available for the State.

Methods and Assumptions

Zasada *et al*. (2005) provided a detailed review of the literature on SMZs and RBBs, as well as a preliminary assessment of the potential extent of the SMZs and RBBs in Georgia using 1997 FIA inventory data, various GIS data, and Landsat TM images. They used LTM-image-based polygons populated using forest industry ground inventories to create a detailed spatial database with forest types, species groups, basal areas, volumes, and site productivities. The resulting spatially explicit database was used together with an estate management simulation model (OPTIONS from D.R. Systems, Inc.). Because this research was a continuation of the studies described in Zasada *et al*. (2005), we applied the assumptions described there to define the current simulation scenarios.

OPTIONS can be used to examine different forest management scenarios including financial, industrial, and policy-related decisions and sustainability analysis. The simulator is based on forecasting information for individual polygons (without optimization). All the records used by the program (including spatial data) are processed annually.

A detailed setup of OPTIONS runs was similar to that described by Cieszewski *et al*. (2003). Because of the focus on stream and road buffers in this study, we added additional management regimes attributed to species groups occupying the analyzed buffers. The major difference between management of various species within and outside of the buffers was that selective harvesting was performed in buffer stands with minimum required residual basal area defined by the BMPs, while clearcutting was allowed only on the nonbuffer areas.

We defined "primary stream buffers" as those created according to BMPs, with widths depending on stream classification and slope. "Primary road buffers" were assumed to have a width of 40 feet, and "secondary stream and road buffers" a width of the widest buffer anticipated in BMPs (100 feet). We followed the BMP recommendations, allowing buffers to be selectively cut with appropriate minimum residual basal area left after harvesting. We considered the following three options of buffer combinations and widths showing various levels of regulatory restrictions:

- Only primary stream buffers.
- Primary stream and road buffers together.
- Secondary stream and road buffers together.

Next, we supplemented all above-mentioned assumptions by two harvesting levels at the State scale. First, we assumed that harvesting in Georgia would remain unchanged in the future, and we set it at 1.5 billion cubic feet per year according to the most recent FIA report on the State's forest resources (Thompson 1998). Because it is likely that wood utilization may increase in the future (e.g., Wear and Greis 2002) we considered also an increasing statewide harvesting level. We assumed that from the current level of 1.5 billion cubic feet per year, harvesting would gradually increase to 2.25 billion cubic feet per /year in 2040, which means that we expect harvesting in the near future to increase by 50 percent over the 1997 harvesting level.

We also considered various intensities of management on the State level. The first variant assumed that about 30 percent of all pine plantations in the State are managed intensively, and no additional intensively managed plantations will be established in the future (Zasada *et al*. 2003). In the second variant we assumed that the intensity of management will increase, and that half of newly established plantations will be managed intensively, which means a transition rate to intensive management plantations of 50 percent.

We ran all the simulations for a 200-year prediction period. By using such a long simulation period we achieved a certain equilibrium between the forest productivity and its harvesting, which changes with forest age structure and regeneration practices and is likely to require more than two rotation periods. In most scenarios, the 200-year simulation period was sufficient to stabilize wood availability on a certain level, which could be assumed to reflect the resource production versus harvesting balance in the distant future. We do not believe that we can predict the state of forests into such a remote future, but instead we intend to determine the impact of different actions on forest resources in the State.

Results

Detailed assessment of the stream and road buffers is summarized in table 1. Narrow stream buffers (40 feet) established according to Georgia's BMPs occupy about 980,000 acres, which makes up 4.01 percent of total forested area of the state. Assuming all buffer widths of 100 feet, the stream buffers would occupy 8.65 percent of forested land. Forests in the determined stream buffers maintain 4.32 and 9.27 percent of total inventoried Georgia's wood volume, respectively. Similar results were obtained for road buffers. Primary (40 feet) road buffers occupy almost 890,000 acres, which makes up 3.64 percent of forested area and 3.52 percent of total volume. Secondary (100 feet) buffers would occupy 2,120,000 acres of forests (8.68 percent of area and 8.40 percent of total volume). These results reveal reasonable proportions. For example, the share of broadleaf species in stream buffers is 2 to 3 times higher than in road buffers. This can be attributed to specific forest types usually occupying riparian area.

We present the results of the simulations graphically by means of changes in inventory volume, and changes in volume available for harvesting. Figure 1 demonstrates results for the conservative scenario assuming no changes in harvesting and intensive management of southern pine stands. In this scenario, even combined wide (100 feet) stream and road buffers do not seem to have a dramatically negative impact on wood availability in the future, allowing for sustainable harvesting in the considered timeframe.

Figure 2 demonstrates results based on the assumption of harvesting in the State gradually increasing during the next 40 years to 150 percent of its current level. In this scenario, it is impossible to maintain sustainable harvesting without increased intensive management, which could compensate for increased demand on wood (fig. 3).

Discussion and Conclusions

Our results showed that introduction of SMZs and RBBs could affect wood supply in the future by excluding more than 17 percent of forest areas from harvesting. The magnitude of this impact depends on the extent of potential buffers, future wood demand, and intensity of management. Considering "the most probable" scenario, however, this impact should be moderate. Other elements of introduction of stream and road buffers also could affect forestry operations, such as an increased cost of management in the protective buffers as suggested by Cubbage and Woodman (1993).

We performed our study using the most commonly available data on streams and roads. Yet, the available data on streams omit many small intermittent and ephemeral streams. According to various researchers in different regions of the country, especially in the west, riparian zones were identified on as much as 60 percent of forested area, and in some cases in Georgia we suspect that stream lengths can be as much as double that reported (mapped) in available sources. Clearly, the knowledge in this area is incomplete and we recommend that the issue be further studied.

Table 1.—*Detailed summary of primary (according to BMP) and secondary (100-feet wide) stream buffers (left) and primary (40 feet) and secondary (100-feet wide) road buffers (right) in Georgia.*

Forest type	Buffer regime	Area [x10^3 ac]	%	Volume [x10^6 ft3]	%
Evergreen	Primary	226	0.93	272	0.81
	Secondary	542	2.15	631	1.88
Mixed	Primary	141	0.58	166	0.49
	Secondary	291	1.19	344	1.02
Deciduous	Primary	613	2.51	1,015	3.01
	Secondary	1,296	5.31	2,147	6.38
Total	Primary	980	**4.01**	1,453	**4.32**
	Secondary	2,112	**8.65**	3,122	**9.27**

Forest type	Buffer regime	Area [x10^3 ac]	%	Volume [x10^6 ft3]	%
Evergreen	Primary	401	1.64	482	1.43
	Secondary	964	3.95	1,160	3.45
Mixed	Primary	225	0.92	265	0.79
	Secondary	521	2.13	615	1.83
Deciduous	Primary	264	1.08	436	1.30
	Secondary	635	2.60	1,052	3.12
Total	Primary	889	**3.64**	1,184	**3.52**
	Secondary	2,120	**8.68**	2,827	**8.40**

Figure 1.—*Changes in inventory volume (left) and volume available for harvesting (right) for scenarios assuming steady harvesting of 1.5 billion cf/year and the current level of intensive management (30 percent of pine plantations). First row: no buffers; second: BMP stream buffers; third: both narrow buffers; and fourth: both wide buffers.*

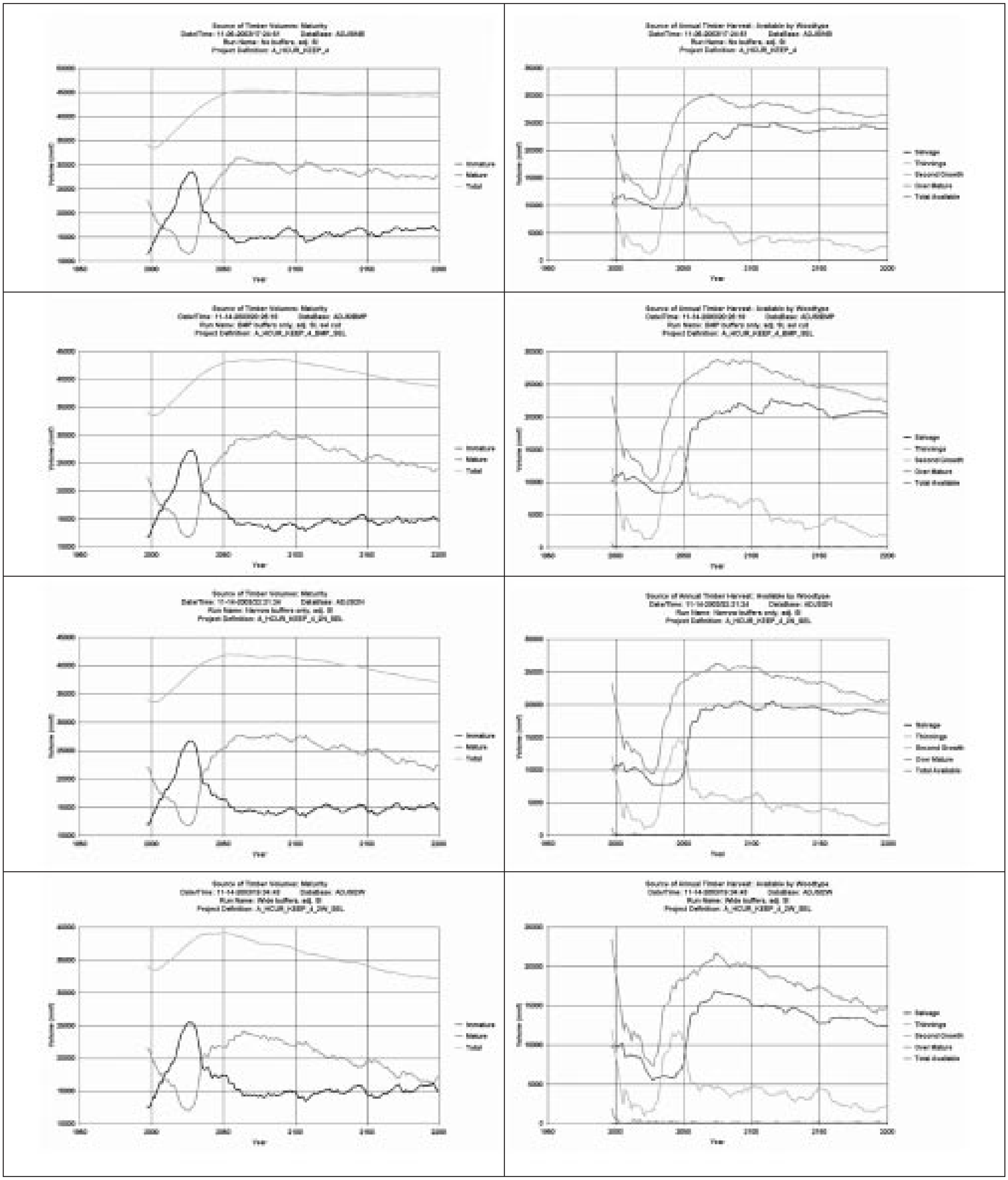


Figure 2.—*Changes in inventory volume (left) and volume available for harvesting (right) for scenarios assuming harvesting increased from 1.5 billion cf/year in 1997 to 2.25 billion cf/year in 2040 and the current level of intensive management (30 percent of pine plantations). First row: no buffers; second: BMP stream buffers; third: both narrow buffers; and fourth: both wide buffers.*

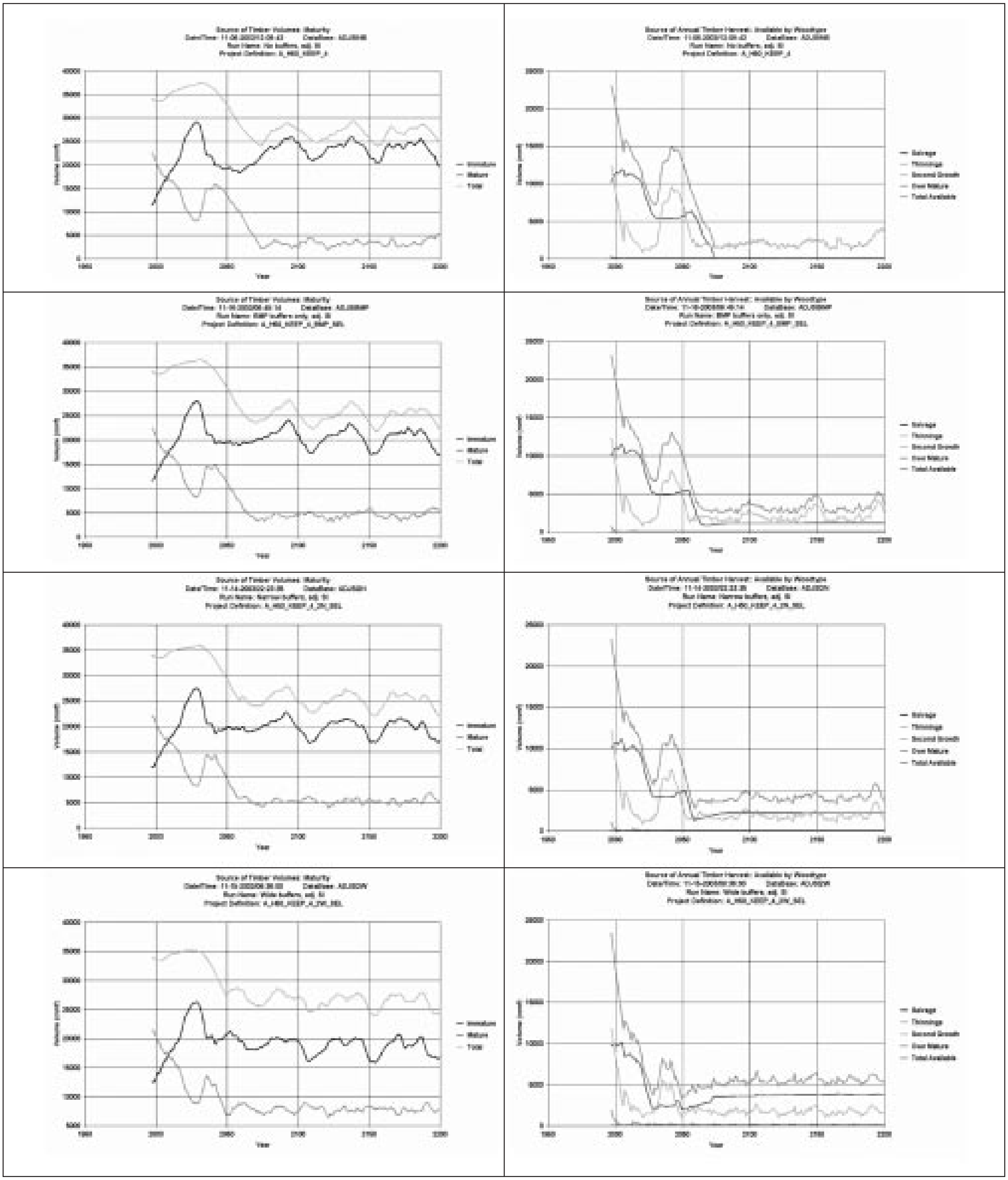
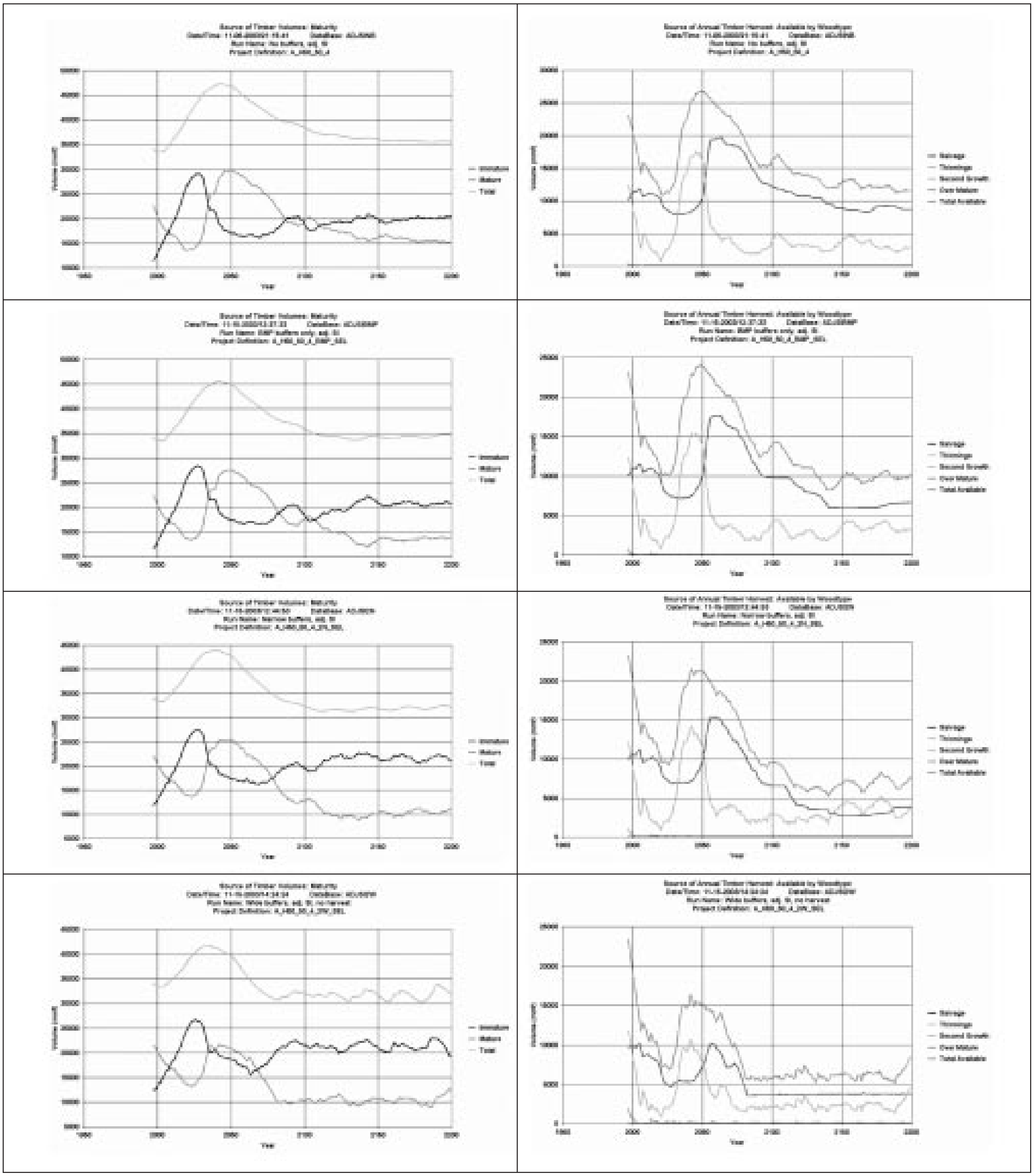


Figure 3.—*Changes in inventory volume (left) and volume available for harvesting (right) for scenarios assuming harvesting increased from 1.5 billion cf/year in 1997 to 2.25 billion cf/year in 2040 and an increased intensity of management (50 percent newly established pine plantations are to be managed intensively). First row: no buffers; second: BMP stream buffers; third: both narrow buffers; and fourth: both wide buffers.*



Increased wood demand, together with a large area of land reserved for protective uses, could significantly decrease volume available for harvesting in the future. Our results showed that allowing for protection of natural areas of special interest and maintaining the region's competitive status in the world market might require other supplementary measures, such as increasing the extent of intensive management practices in commercial forests (Sedjo and Botkin 1997).

In this study we have not considered any analyses of impact of urban expansion on long-term fiber supply in the State. In all probability, progressive urbanization will further contribute negatively to availability of forest areas and volumes available for harvesting.

Literature Cited

Cieszewski, C.J.; Zasada, M.; Borders, B.E.; *et al.* 2003. Spatially explicit sustainability analysis of long-term fiber supply in Georgia, USA. Forest Ecology and Management. 187(2–3): 345–359.

Cubbage, F.W.; Woodman, J.N. 1993. Impacts of streamside management zones on timber supply in Georgia. Southern Forest Economics Workers Meeting; 1993 April 23–24; Durham, NC: 130–137.

Georgia Forestry Commission (GFC). 1999. Georgia's best management practices for forestry. Georgia Forestry Commission.

Hansen, M.H.; Frieswyk, T.; Glover, J.F.; Kelly, J.F. 1992. The eastwide forest inventory database: users manual. Gen. Tech. Rep. NC-151. St. Paul, MN: U.S. Department of Agriculture, Forest Service, North Central Forest Experiment Station. 48 p.

Miles, P.D.; Brand, G.J.; Alerich, C.L.; *et al.* 2001. The forest inventory and analysis database: database description and user's manual, version 1.0, revision 8. St. Paul, MN: U.S. Department of Agriculture, Forest Service, North Central Forest Experiment Station.

Ruefenacht, B.; Vanderzanden, D.; Morrison, M.; Golden, M. 2002. New technique for segmenting images. RSAC program manual. U.S. Department of Agriculture, Forest Service, Remote Sensing Application Center. 14 p.

Sedjo, R.A.; Botkin, D. 1997. Using forest plantations to spare natural forests. Environment. 39(10): 15–20, 30.

Thompson, M.T. 1998. Forest statistics for Georgia, 1997. Resour. Bull. SRS-36. Asheville, NC: U.S. Department of Agriculture, Forest Service, Southern Research Station. 92 p.

Wear, D.N.; Greis, J.G. 2002. Southern forest resource assessment. Gen. Tech. Rep. SRS-53. Asheville, NC: U.S. Department of Agriculture, Forest Service, Southern Research Station. 635 p.

Welsch, D.J. 1991. Riparian forest buffers: function and design for protection and enhancement of water resources. NA-PR-07-91. Radnor, PA: U.S. Department of Agriculture, Forest Service, Northeastern Area, State and Private Forestry.

Wenger, S.J. 1999. A review of the scientific literature on riparian buffer width, extent, and vegetation. Athens, GA: Public Service & Outreach, Institute of Ecology, University of Georgia. 59 p.

Zasada, M.; Cieszewski, C.J., Borders, B.E. 2003. Impact of intensive management practices on long-term simulations of forest resources in Georgia. In: Proceedings, Society of American Foresters 2002 National Convention; 2002 October 5–9; Winston-Salem, NC. SAF Publication. 03-01: 64–70.

Zasada, M.; Cieszewski, C.J.; Lowe, R.C.; Zawadzki, J. 2005. Using FIA and GIS data to estimate areas and volumes of potential stream management zones and road beautifying buffers. In: Proceedings of the Fourth Annual Forest Inventory and Analysis Symposium; 2002 November 19–21; New Orleans, LA: U.S. Department of Agriculture, Forest Service, North Central Research Station: 253–257.